# An essay on regional geology and stratigraphy of the Upper Cretaceous deposits of southern Urals territories

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## ABSTRACT

The Turgay region is considered as the north-eastern border of the Peri-Tethyan basins during the Cretaceous. This area contained elements of each area's faunas; the relatively warm Peri-Tethys faunas with the cooler West Siberia faunas. Cretaceous deposits are found throughout the southern Urals, especially in the western and southern Primugodzharie, Aktyubinskian Priuralie, and Pri-Irgizsky areas. Cretaceous deposits are covered by Cenozoic rocks, shown from well cores of the south-eastern border of Mugodzhar mountains, Turgay and northern PriAralie. The Lower Cretaceous in the southern Urals was predominately continental. In the western Primugodzharie and Aktyubinskian Priuralie region, marine sediments of Neocomian, Aptian and Albian age were deposited. Red continental sedimentary rocks were deposited during the Neocomian. Coal and bauxite were deposited during Aptian and Albian. The Lower Cretaceous boundary was marked by a marine regression, while the Aptian and late Albian-early Cenomanian are characterized by extensive continental rocks on the entire territory, with the exception of the Turgay region. A widespread marine transgression is evident during the Cenomanian.

**KEY WORDS**
stratigraphy, correlation, Cretaceous, South Ural, paleontology.

This transgression influenced the sedimentation in the southern Urals, East European, Scythian, Turan and West Siberian platforms. Upper Cretaceous was dominated by shallow marine facies, coastal and shore deposits. Marine transgression continued until late Maastrichtian. The end of the Late Maastrichtian was characterized by the appearance of very shallow water and lagoonal regressive facies. The Cretaceous/Paleogene boundary was marked by a pause of sedimentation with erosional unconformities in the boundary between the Maastrichtian and Danian. Foraminifera, radiolaria, belemnites, selachians, mollusca, pollen, and spore reveal the timing of events and suggest the paleoenvironment of this region during the Upper Cretaceous.

**RÉSUMÉ**

La région de Turgay représente la bordure nord-orientale de l'ensemble Péri-Téthysien au Crétacé. Cette région comprend des éléments des diverses provinces fauniques; des faunes Péri-Téthysiennes relativement chaudes et des faunes froides Sibériennes. Des dépôts Crétacés existent partout dans l'Oural méridional, et particulièrement dans les zones occidentales et méridionales de Prémugodzharie, du PériOural Aktyubinskien, et les zones de Péri-Irgizsky. Des forages de la bordure sud-orientale des monts Mugodzhar, Turgay et de PétiAralie septentrionale ont révélé que les sédiments Crétacés sont recouverts de roches Cénozoiques. Le Crétacé inférieur de l'Oural septentrional est essentiellement continental. Dans le Primugodzharie occidental et la région du PériOural d'Aktyubinsk, des sédiments matins du Néocomien, de l'Aptien et de l'Albien existent. Des roches sédimentaires continentales rouges se sont déposées au cours du Néocomien, puis du charbon et de la bauxite à l'Aptien et à l'Albien. La limite inférieure du Crétacé est marquée par une régression marine alors que l'Aptien et l'Albien supérieur-Cénomanien inférieur est caractérisé par une grande extension des dépôts continentaux, sur l'ensemble du territoire, sauf dans la région de Turgay. Une large transgression marine se manifeste au Cénomanien. Cette transgression a influencé la sédimentation dans l'Oural méridional, l'Europe orientale, et les plates-formes Scythienne, de Turan et de Sibérie occidentale. Le Crétacé supérieur fut dominé par des faciès de mer peu profonde, et des dépôts côtiers et de rivage. La transgression marine a continué jusqu'au Maastrichtien supérieur qui s'est terminé par des faciès très peu profonds et régressifs lagunaires. La limite Crétacé/Paléogène fut marquée par une pause de sédimentation et des discontinuités érosives à la limite Maastrichtien-Danien. Les foraminifères, radiolaires, bélemnites, sélachians, mollusques, pollens, et spores indiquent la chronologie des événements et révèlent les types de paléoenvironment de cette région au cours du Crétacé.

**MOTS CLÉS**
stratigraphie,
corrélation,
Crétacé,
Oural méridional,
paléontologie.

## INTRODUCTION

Tectonic activity in the Uralian mobile belt ceased at the beginning of the Mesozoic, completing the suturing of the Russian platform and West Siberian plate. A new tectonic regime began to evolve. During the Late Jurassic-Lower Paleogene, the Uralian epihercynian platform was generally uplifted. Mountain building coupled with erosion were the predominate mechanisms during this time. Thin beds of continental sediments were accumulating in the surrounding basins.

During the early part of the Cretaceous, the northern portion of the Urals downwarped at a faster rate. A transgressive cycle flooded this region with northern boreal waters. This epicontinental sea was a mixture of waters from the Polar, North Atlantic and North Pacific paleobasins. The southern portion of the basin was not invaded, as there is only evidence of continental sedimentation in local depressions.

During the later part of the Cretaceous, the southern portion of West Siberia was tectonically downwarped allowing the transgressions to fully invade the Russian Platform, West Siberian Basin and Peri-Tethyan basins of the Turanian Plate. The Turgay trough allowed the north-western portion of central Asia and north-western Kazakhstan to experience marine conditions (Papulov 1974).

This connection influenced the microbiota of West Siberian during the Late Cretaceous. Elements of the Terhyan fauna are found in semi-isolared marine basins. Components of foraminifera, radiolarian and mollusca of the West Siberian region can be correlated to the fauna of the Peri-Tethyan region. The Turgay Trough records this mixed fauna.

The Turgay Trough is situated between the eastern slope of southern part of the Ural Mountains and the Kazakh Shield. The northern Turgay area has well preserved Upper Cretaceous assemblages and is a reference section for foraminifera and radiolaria for Cenomanian, Conacian, Santonian, Campanian, and Maastrichtian. Upwarping in the north near Kustanay City, Kazakhstan, was the southern limit between the West Siberian basin. South of this area marked the area of the Peri-Tethyan basins, where arctic-boreal waters of West Siberia mixed with the warm waters of the Peri-Tethys. This basin has faunal representatives of the warm waters of Peri-Tethyan basins with the arctic-boreal faunas of West Siberian basins. These assemblages are key to understand the interaction of the West Siberian, European, and Peri-Tethyan basins. Understanding the biostratigraphy in the Cretaceous of the southern Urals will help to correlate timing of events of the Peri-Tethys and West Siberia.


Fig. 1. — Location map. **1a**, Or'-Ilek Hills area; **1b**, Mugodzhar Mountains; **1c**, eastern Mugodzhar Mountains; **2a**, Aktyubinskian Priuralie; **2b**, western Primugodzharie; **2c**, southern Primugodzharie; **3a**, north-eastern Usturt; **3b**, northern PriAralie; **4a**, western side of Turgay Trough; **4b**, south-western Turgay; **4c**, Turgay Trough; **4d**, eastern side of Turgay Trough.

## STUDY AREA

This area encompasses a vast region (Fig. 1), with few outcrops. The termination of the Urals in the south is bordered by the Or'-Ilek Hills and Mugodzhar Mountains. The Or'-Ilek Hills (altitude 30-509 m) represents the divide between the Or' and Ilek Rivers basins. The Or'-Ilek Hills are approximately 100 km wide, ranging from Orsk City on the east to Aktyubinsk City on the west; and 200 km long, extending from the Ural River Valley on the north, to Kandagach in the

south. The Mugodzhar Mountains are low mountains south of the Or' River. The Mugodzhar Mountains consist in several ranges and groups of low mountains and hills. The highest peaks are approximately 650 merers. The Shoshkakolian Range (altitude 274-408 m) is the most southern extension of the Mugodzharian Range.

The Poduralian area (Embian Plateau) is southwest of the Or'-Ilek Hills, Mugodzhar Mountains and Shoshkakolian Range. The Embian Plateau is an erosional surface draining toward the PriCaspian lowland. The East Mugodzharian plateau is north-east of the Mugodzhar mountains and south of the Or' River. The East Mugodzharian plateau drains toward the Turgay plateau.

The south-western portion is formed by the north-eastern frame of the Ustyurt Plateau (100-200 m) and the Shagray Plateau (100-150 m) and the Shoshkakolian Range in the south. The PriAralian Plain (150 m) is the territory north of Aral Lake. It contains the sandy Bolshie, Malye Barsuki, Barshakum and PriAralian Karakum Deserts. The eastern portion of Turgay Trough is the Turgay Plateau. It is spread between the massifs of the southern Ural mountains, east of the Mugodzhar Mountains and west of the low lying Kazakh Melkosopochnik Hills, Central Kazakh. The length is around 800 km (north-south), and width (east-west) is 300-450 km.

The south-western part of Turgay Plateau, adjoining to the East Mugodzhar Plateau, is called the Pri-Irgiz Plain (150 m). The western part of the Turgay plain is the eastern border of Zauralian Plateau (altitude 250-350 m). The Turgay Plain in the north is called the Kustanay Plain (altitude 170-220 m); the central part is called the Aday-Ul'kayak plateau (altitude 220-300 m); the east is called the East Turgay Plateau (200-400 m) and the south is called the South Turgay Plain (altitude 150-180 m) (Miletsky, 1981; Ozhiganov 1964; Zakharov & Udri 1971; Vereschagin *et al.* 1975; Gerasimov *et al.* 1968; Yanshin 1953).

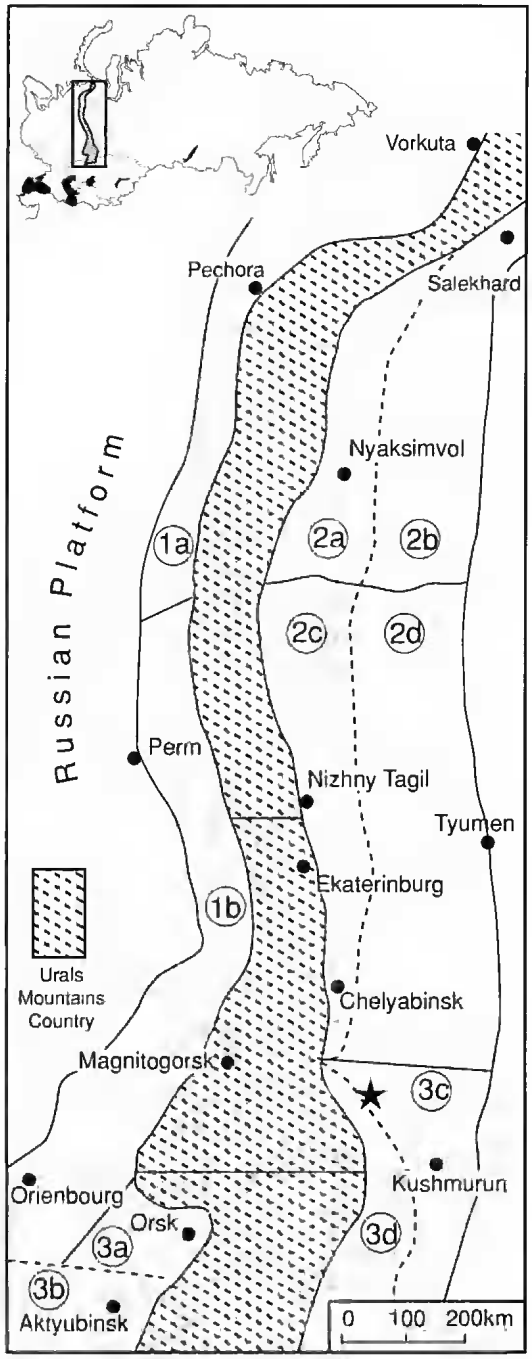


FIG. 2. — Scheme of structural-facies subdivision of the Urals during the Cretaceous. **1**, Preduralie; **1a**, Polar, Pripolar and northern Preduralie; **1b**, middle and southern. **2**, Zauralie; **2a**, Pripolar and north-western Zauralie; **2b**, Pripolar and north; **2c**, middle and south-west; **2d**, middle and south. **3**, Predmugodzharie; **3a**, Orsky area; **3b**, Khobdinsky, Ileksky, and Zhurunsky area; **3c**, north-west Turgay; **3d**, north-east Turgay.

## STRUCTURAL OVERVIEW OF AREA

The Urals are divided into areas that reflect dif-

ferences in structure and depositional environments. The Russians refer to these as structural-facies divisions. Figure 2 shows the general scheme of the structural-facies divisions of the Urals during the Creraceous. This paper emphasizes the Upper Cretaceous events that occurred in the southern termination of the Urals and adjacent territories (Fig. 2; 3a-d))

The southern Urals is subdivided into four main structural-facial zones (Fig. 1): (1) southern termination of the Ural Zone; (2) western adjoining plains or Primugodzharie and north-eastern Pricaspian Zones; (3) southern adjoining plains or PriAralie and north-eastern Ustyurt Zones; and (4) eastern adjoining plains or Turgay Zone. The Or'-Ilek Hills area corresponds to the Central Uralian anticlinorium and includes the area west of the Kosisteksky region (the southern continuation of the Sakmarian Zone of southern Urals), and the area east of the Kempirsaysky region (continuarion of South Uralian Zone).

The Mugodzhar Mountain area (Fig. 1: 1a-c) includes the southern terminations of three widespread Uralian regional structural units: Tagil-Magnitogorskian synclinorium, East Uralian anticlinorium, and portions of the Zauralian anticlinorium.

The Primugdozharie Zone (Fig. 1: 2a) includes the area west of the Mugodzhar Mountains and is referred to as the Aktyubinskian Priuralie area. This corresponds to Aktyubinskian pericline trough of the Ural fold system, which is partly covered by Mesozoic-Cenozoic blanket deposits. The western Primugodzharie (Fig. 1: 2b) is a broad belt west of the Mugodzhar Mountains. This area corresponds to the Kempirsayskian Zone of Central-Uralian anticlinorium and to the eastern border of Pri-Caspian depression of East European platform. The western portion of the western Primugodzharie and southern Primugodzharie areas are similar to the east-north-eastern parts of the PriCaspian lowland area. In the southwest area of the Mugodzhar Mountains, the region referred to the southern Primugodzharie is located (Fig. 1: 2c). The Shoshkakolian Range is located in this region and is considered as a continuation of the Mugodzhar Mountains, which is equivalent to the eastern part of south Emba area (Zakharov & Udris 1971; Sobetski 1982).

The PriAtalie Zone is located in the southern adjoining plains (Fig. 1: 3a, b) The western portion is referred to the north-eastern Ustyurt region. It is formed by horizontally bedded Neogene, Oligocene, Eocene, and Cretaceous deposits. This area is equivalent to the eastern part of the PriUstyurt area. The northern PriAralie adjoins the North Aral Lake and is characterized by a Paleozoic geosyncline basement and thick Mesozoic-Cenozoic sedimentary cover.

The Turgay zone (Fig. 1: 4a-c) includes the Turgay Plateau from the West Siberian plain in the notth to the PriAralian Karakum Desert in the south. There are several fold systems identified in this area, including the Kustanayan synclinorium, Ubaganian anticlinorium, Aksuatskian synclinorium, and Esilskian synclinorium. In the eastern slope of the Urals, the Zauralian anticlinorium is the western border of the Turgay trough. The south-western Turgay region is situared between the Mugodzhar mountains and the northern PriAralie. This area has a deeply folded basement with a well developed sediment cover. In the southern portion is the boundary between the Central Kazakhstan fold system, PreCambrian and Early Paleozoic rocks outcrop in the Ulytauskian anticlinorium and form the eastern frame of Turgay trough. This region is referred to as the eastern border of Turgay trough or eastern Turgay. These boundaries are well documented in the literature (Miletsky 1981; Ozhiganov 1964; Zakharov & Udris 1971; Yanshin 1971; Vereschagin *et al.* 1975; Moskvin 1986, 1987; Naidin *et al.* 1986; Papulov 1974).

## STRATIGRAPHY OF CRETACEOUS DEPOSITS

### CENOMANIAN (Figs 3-5)

During the Cenomanian, the southern Urals range from continental to marine. Continental and semi-marine (lagoonal lacustrine) rocks of upper Albian to lower Cenomanian (Alrykudukskaya Formation). Coastal marine rocks are characteristic of the Nogaytinskaya Formation (Primugodzharie and PriAralie) in the Primugodzharie and PriAralie regions. Semimarine and continental rocks of Cenomanian-

Turonian age (Shetiregizskaya and Novokozyrevskaya Formation) are located in Turgay. Lower-middle Cenomanian coastal marine deposits are found in the western Primugodzharie and Aktyubinskian Priuralie. Upper Cenomanian deposits in the western areas are absent.

The late Albian - early Cenomanian Altykudukskaya Formation occurs on marine deposits of the Aptian-Albian Bogdanovskaya Formation in the Aktyubinskian Priuralie region. The Altykudukskaya Formation in western Primugodzharie and Or'-Ilek Hills is unconformably laid on Paleozoic rocks. In the southern Primugodzharie, north-eastern Ustyurt and northern PriAralie, the Altykuduskaya Formation lies on the continental deposits of the Aptian-Albian Karashataukskaya and Kysylshenskaya Formation. In the western area the Altykudukskaya Formation has surface outcrops. Throughout the rest of the region, the depth has been determined by boreholes (Zhelezko & Segedin 1972; Miletsky 1981).

The Altykudukskaya Formation mainly consists of white to yellow, siltstones to conglomerates, unconsolidated clays to gravel, with sandy concretions and plant debris. Two sections can be recognized. The lower unit contains light grey to yellow-grey, poorly sorted, quartz rich sands in horizontal or slanting beds. Gravel and pebbles are found in the sand layers with kaolinite. The total thickness of the lower unit ranges from 20-120 m. Spores and pollen (SPA IV.1) from early Cenomanian age are found in the lower units.

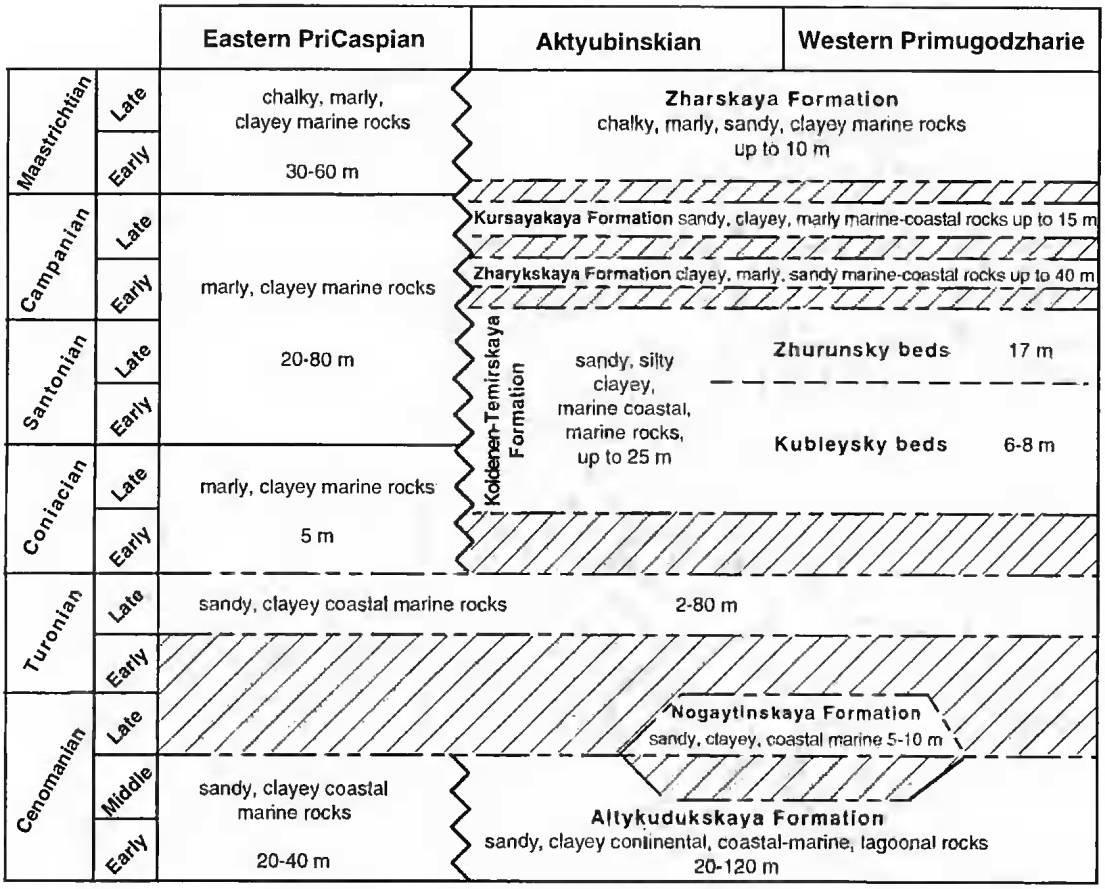


FIG. 3. — Correlation of Upper Cretaceous deposits of eastern PriCaspian, Aktyubinskian Priuralie, and western Primugodzharie.

The upper portion of the Altykudukskaya Formation is found in the western areas and has well preserved selachia (shark teeth) which are from the *Palaeoanacorax volgensis* Zone of Albian-early Cenomanian age (Zhelezko & Segedin 1972). Flora from the Koldenen-Temirskian paleoflora (LFA 1) of late Albian-Cenomanian age is found in sandy horizons (Shilin 1986).

In the eastern PriCaspian region, transgressive Cenomanian coastal and deeper marine deposits are found on continental Albian rocks. The Cenomanian rocks in this area consist of yellow-grey, green-grey, yellow, quartz rich glauconite sands, grey sandy clays, and sandstones. Ammonites of the *Kamaroites grossouvrei* Zone (early-middle Cenomanian); selachians of the *Palaeoanacorax obliquus* Zone (early-middle Cenomanian); mollusca of *Oxytoma pectinata* Zone (early Cenomanian); and foraminifers of the *Gavelinella cenomanica* Zone (early-middle Cenomanian) are found. The total thickness ranges from 20-40 m (Nevesskaya 1985; Azbel & Grigyalis 1991).

The western Primugodzharie, transgressive deposits of marine quartz sands, siltstones and clayey siltstones of the Nogaytinskaya Formation overlies continental deposits of the Altykudukskaya Formation. The total thickness of the Nogaytinskaya Formation is 5-10 m. Typically clayey siltstones are in the upper portion, with beds of mollusca and selachians of the *Palaeoanacorax obliquus* Zone toward the middle

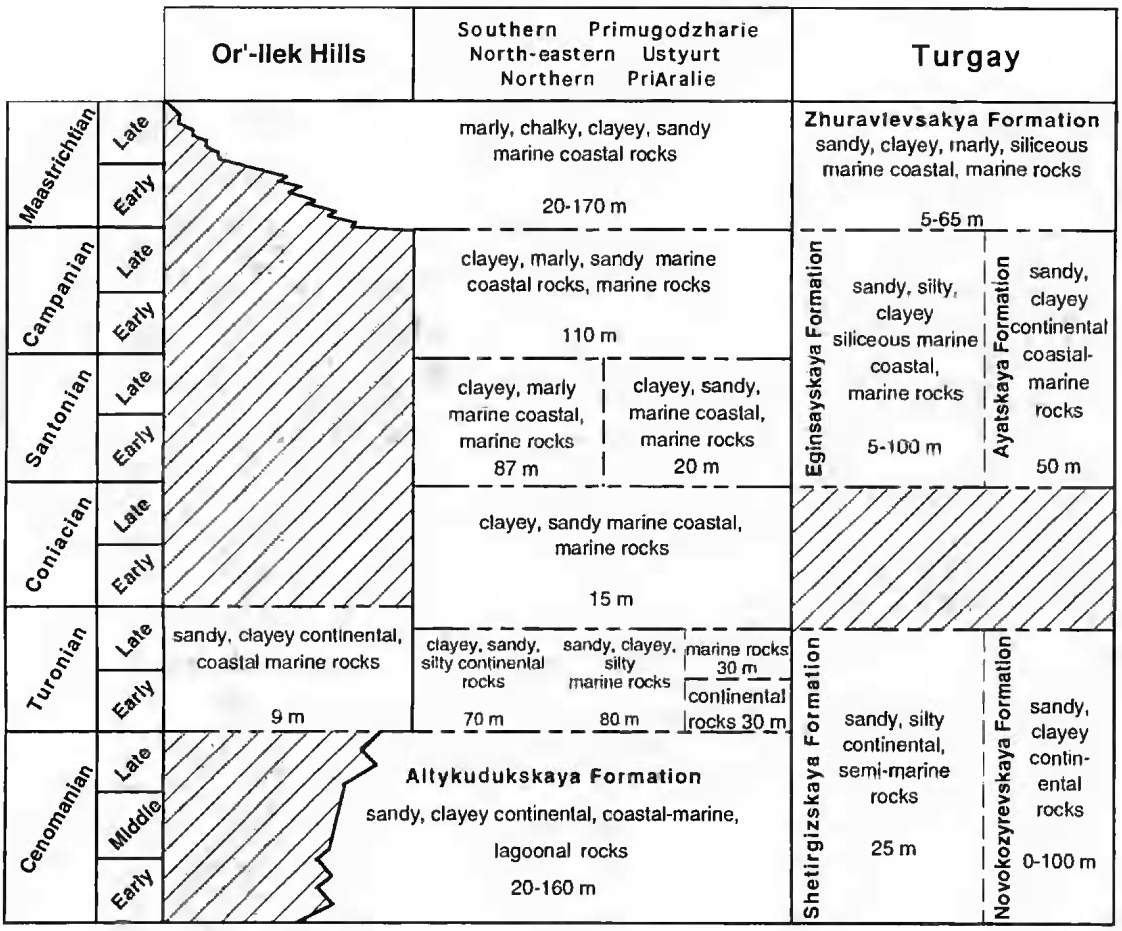


FIG. 4. — Correlation of the Or'-Ilek Hills, southern Primugodzharie, and Turgay.

to lower portion of the section. Conglomerates and sandstones are in the bottom of the section (Zhelezko & Segedin 1972).

CENOMANIAN-TURONIAN (Figs 3-5)

The Cenomanian-Turonian rocks are widespread in the Turgay trough and represented by the Shetirgizskaya Formation (continental to semi-marine) and Novokozyrevskaya Formation (continental). Surface outcrops are only found in erosional and karst depressions.

Composition of the Shetirgirzkaya Formation varies with the area. In the northern part of the Turgay trough, the Shetirgirzkaya Formation is about 10 m thick, composed of green-green monmorillonite-beidellite sandy silty clay to kaolinite clays with lignite, coal and pyrite. This section lies unconformably on Carbonifereous limestones, with Santonian marine deposits lying on top of the section (Papulov *et al.* 1990).

In the southern part on the Kazakh Republic, the deposits are thicker (up to 60 m) and range from coarse grained sandstones to silty claystones, with some plant debris. The lower portion of the Shetirgizkaya Formation contains spores/pollen of early Cenomanian age, while the upper portion corresponds to late Cenomanian-early Turonian. Flora of Cenomanian-Turonian age is also found of the Ayatskian regional flora (Shilin 1986). Marine deposits of the Santonian age lie on top, while Albian grey clays are at the base of the section.

The Novokozyrevskaya Formation lies on weathered Paleozoic rocks throughout the region. Overlying disconformably varies from Santonian, Campanian, Maastrichtian or Paleogene, depending on the location. A 43 m section is found in the Novokozyrevsky quarry, near the Tobol River near the town of Oktyabrsky. The bottom of the section contains kaolinite-hydromica clays with clasts of Paleozoic rocks. A 15 m layer of bauxite, which is commercially mined, is present up in the section. The top of the section is approximately 15 m of kaolinite-gibbsite dark clay with lignite and coaly plant deposit, with the uppermost containing bauxite with plant remains.

The Novokozyrevskaya Formation throughout this region ranges in thickness from 0-100 m.. It can be characterized by three parts including a lower coarse grained sandstone, a middle bauxite bearing layers, and an upper kaolinite clay with plant remains. The lower part usually contains spores/pollen association of early Cenomanian age, with the middle and upper layers containing late Cenomanian-early Turonian age (Papulov *et al.* 1990).

There are other Cenomanian-Turonian deposits in the western side of the Turgay trough, deposited in a lacustrine/continental environment. It outcrops in karst depression and other erosional regions. Near the Ayat River, an outcrop of approximately 16 m is found. The base of the section has sandstones with Paleozoic weathering debris. Kaolinite clays with lignite overly grade into quartz rich sands toward the top of the section. Santonian oolitic bearing sands are found lying conformably on the top of the section. This deposit contains spores/pollen of late Cenomanian-early Turonian age, with a flora assemblage of Turonian age called the Ayatskian-Kazakhstanian flora (Shilin 1986).

In the north-eastern corner of the Turgay region, the Upper Cretaceous sedimentary sequence of Turgay, is replaced by West Siberian sequences. The semi-marine deposits of Shetirgizskaya Formation is gradually replaced by the semi-marine West Siberian Uvatskaya Formation, which contains the *Trochammina wetteri-Trochammina subbotinae* Zone of late Cenomanian. The radiolarian zonation also correlates a late Cenomanian age (*Cenodiscus cenomanicus-Stichocapsa ferosia uvatica* Zone).

TURONIAN (Figs 3-6)

Continental, marine, and coastal-marine deposits of Turonian age are widespread in southern Primugodzharie, northern PriAralie, and Turgay Trough in subsection. The thickness of Turonian deposits ranges from several meters in the north to 80 m in the south in the southern Primugodzharie, and increases to 300 m in the PriAralie region.

In the Aktyubinskian Priuralie, deposits of Turonian age are found on Cenomanian sandstones along the Ilek River. Marine clay rich quartz sandstones and clays (up to 12 m) are found with *Inoceramus* and ammonites of the late Turonian *Inoceramus labiatus* Zone and foramini-

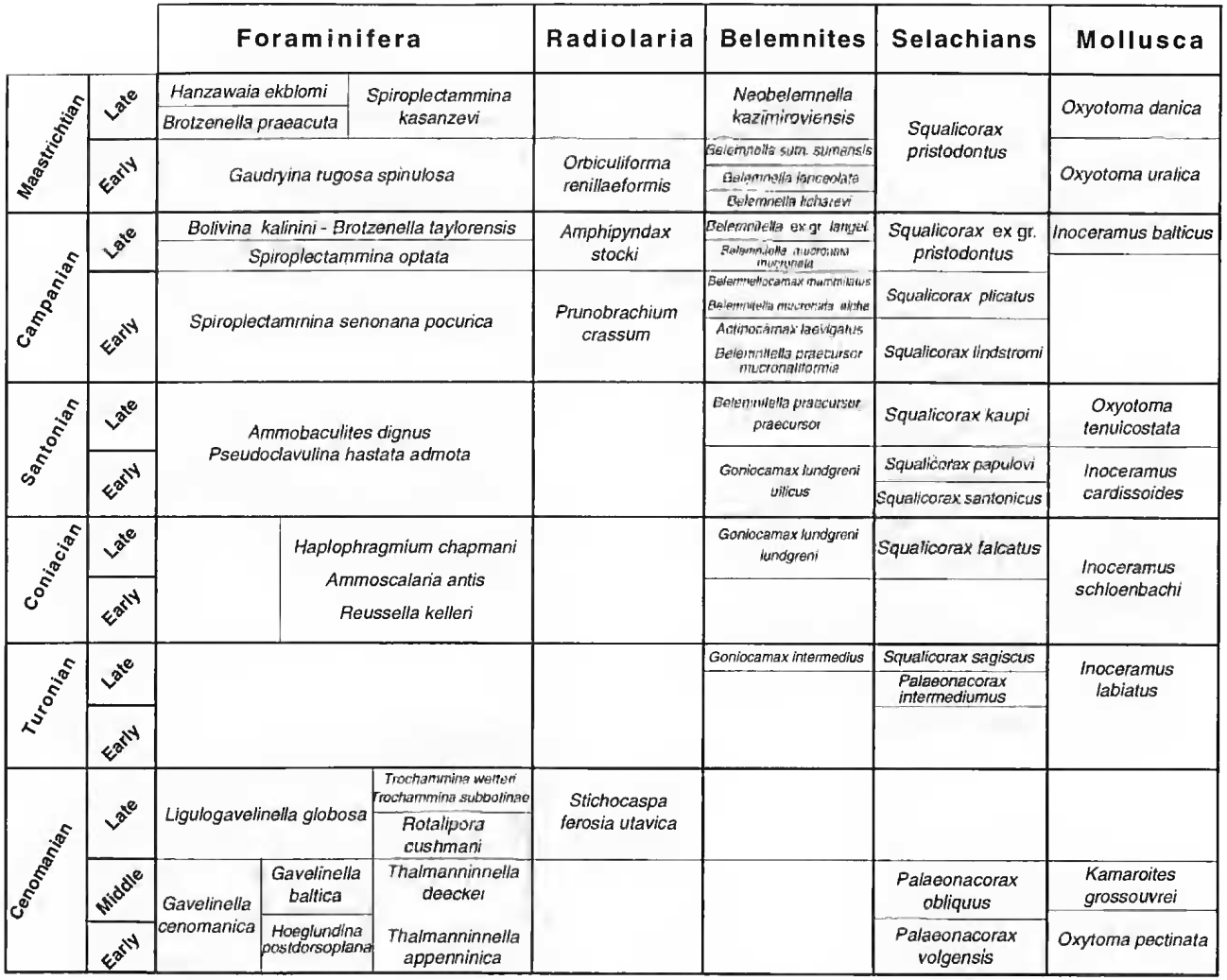


FIG. 5. — Correlation of foraminiferans, radiolarians, belemnites, selachians, and mollusca in the southern Urals region (adapted from Naidin *et al.* 1984a, b; Naidin & Kopaevich 1977; Azbel & Grigyalis 1991).

fers of the late Turonian *Gavelinella moniliformis* Zone. Santonian rocks are found conformably on top of this section.

In the Kazakh Republic, near Novofedorovsky, a 13 m section lies on Cenomanian sandstones. The section contains a phosphoritic horizon of concretions in quartz-glauconite sandstone. Dark grey to green grey clayey marls are found in the rest of the section. The section is overlain by Santonian phosphoritic layer.

In the Or'-Ilek Hills area, in the Kirgeldinsky graben on the Ural River, the Turonian is represented by micaceous quartz rich sandstones and siltstones. *Inoceramus lamarcki* park can be found in this region.

The Turonian deposits of the southern Primugodzharie outcrop near the flanks of the Shoshkakolian anticlinorium. In the northern portion of this area the deposits are continental, but become more influenced by marine sedimentation in the south of the Shoshkakolian Range area. On the Ustyurt plateau and in the north-western part of the PriAralie (Kulandy Peninsula of the Aral Lake), the Turonian deposits are marine. In the south-eastern Turgay area, the Turonian rocks range from continental (earliest sedimentation) to coastal-marine (latest). Continental deposits of kaolinite clays, sandstones, and siltstones are called the Zhirkindekskaya Formation in the southern Primugod-

| | | Russian Platform | Western Kazakhstan | Crimea, Caucasus, Carpathians |
|---|---|---|---|---|
| Maastrichtian | Late | *Hanzawaia ekblomi* | *Pseudotextularia varians* | *Abathomphalus mayaroensis* |
| | | | *Brotzenella praeculata* | |
| | Early | *Brotzenella complanata* | *Bolivinoides draco draco* | *Globotruncana stuarti* |
| | | | *Brotzenella complanata* | |
| | | *Angulogavelinella gracilis* | | |
| Campanian | Late | *Globorotalites embdyensis* | *Brotzenella taylorensis*<br>*Bolivina kallnini*<br>*Cibicidoides volzianus* | *Globotruncanita morozovae* |
| | | *Brotzenella montereiensis* | | |
| | Early | *Cibicidoides termirensis* | *Cibicidoides termirensis* *Cibicidoides aktulagayensis* | |
| | | | *Bolivinoides decoratus decoratus* | |
| | | *Gavelinella clementiana clementiana* | | |
| Santonian | Late | *Gavelinella stelligera* | *Bolivinoides strigillatus* | *Globotruncana fornicata* |
| | | | *Osangularia whitei whitei* | |
| | Early | *Gavelinella infrasantonica* | *Stensioeina granulata perfecta* | *Globotruncana concavata* |
| Coniacian | Late | *Gavelinella costulata* | *Stensioeina exculpta granulata* | *Globotruncana primitiva* |
| | | | *Stensioeina granulata granulata* | |
| | Early | *Gavelinella kelleri* | | *Globotruncana angusticarinata* |
| Turonian | Late | *Gavelinella moniliformis* | *Gavelinella praeinfrasantonica* | *Globotruncana lapparenti* |
| | | *Gavelinella ammonoides* | *Gavelinella moniliformis* | |
| | Early | *Gavelinella nana* | *Globorotalites hangensis* | *Helvetoglobotruncata helvetica* |
| | | | *Hedbergella holtzi* | |

FIG. 6. — Correlation of foraminifera zones from the Russian Platform, western Kazakhstan and Crimea, Caucasus, and Carpathians (western part of the west European Paleobiogeographic provinces).

zharie, northern PriAralie, and south-western Turgay.
Marine deposits of Turonian-Coniacian age composed of greenish monmorillonite with admixture of kaolinite, with interlayers of glauconite quartz rich siltstones, clayey siltstones, and fine grained sandstones are found in Northern PriAralie. The total thickness of these deposits are approximately 100 m. These deposits contain macrofossils of the late Turonian *Inoceramus labiatus* Zone and Coniacian *Inoceramus schloenbachi* Zone (Yanshin 1953).
In the eastern PriCaspian region, late Turonian deposits are light grey - grey sandy limestones, carbonate sands, with a phosphoritic horizon in the base. The total thickness ranges from 2-25 m. These marine deposits contain macrofossils of the late Turonian *Inoceramus labiatus* Zone, *Squalicorax sagisicus* Zone and the foraminiferal *Gavelinella moniliformis* Zones. Continental deposits contain spore/pollen in the SPA IV.3 Zone.
The Ayatskaya Formation in Turgay, was formerly considered Turonian deposits, but is not considered Turonian in this study. In the north-eastern region of the Turgay region near the boundary of the West Siberian platform, the Turgay faunas are replaced by West Siberian faunas. The foraminifera and radiolaria indicate Turonian age in the West Siberian Uvatskaya and Kuznetsovskaya Formations (Amon 1988, 1990).

CONIACIAN (Figs 3-6)
Coniacian deposits are absent from the majority of the region, but are found in the extreme west, south, and east. These deposits may have been eroded during a very dynamic transgression during the Santonian-Campanian.
In the Western Primugodzharie region, marine rocks of Coniacian age are present. They are chalky marls, marls and clays with a thickness of approximately 5 m. In the south-western to southern Primugodzharie, 15 to 20 m of marine blue-grey sandy limestones with phosphoritic concretions and sandy carbonate claystones are Coniacian. This deposit contains the molluscan *Inoceramus schloenbachi* Zone and the foraminiferal *Gavelinella kelleri* Zone (early Coniacian) and late Coniacian *Gavelinella costulata* and *Stensioeina granulata granulata* Zone.
In western Primugodzharie and Aktyubinskian Priuralie, the upper Coniacian deposits are represented by the lower portion of the Kubleyskie beds, which is found in the basal section of the Koldenen-Temirskaya Formation. It is light green, fine grained sandstones and siltstones with a phosphoritic unit (Zhelezko & Segedin 1972; Zhelezko 1987, 1988). Upper Coniacian belemnites of the *Goniocamax lundgreni lundgreni* Zone and selachians of the *Squalicorax falcatus* Zone are found in this horizon. These are transgressive deposits found on Cenomanian sandstones of the Altykudukskaya Formation; on marls of Turonian age; and/or on deposits of the Zhirkindekskaya Formation. In the Turgay Trough, Coniacian intervals are not found. Sedimentological evidence shows that they were probably eroded. It has been suggested that portions of the Eginsayskaya Formation, in the northern part of Turgay, is Coniacian. This correlation is only possible because the Eginsayskaya Formation in West Siberia contains Coniacian foraminifers of the *Haplophragmium chapmani-Ammoscalaria antis-Reusella kelleri* Zone and Coniacian radiolarians of the *Ommatodiscus mobilis* Zone (Amon 1988, 1990).

SANTONIAN-CAMPANIAN (Figs 3-6)
Marine deposits of Santonian-Campanian age are found in the western Primugodzharie and Aktyubinskian Priuralie. Upper Coniacian-lower Campanian deposits of the Koldenen-Temirskaya Formation includes two lithologic units. The lower unit is sandy-phosphoritic Kubleskie Beds and is 9 m thick. The upper unit is a phosphoritic siltstone, 17 m thick, called the Zhurunskie Beds. Lower-upper Campanian Zharykskaya Formation and upper Campanian Kursayskaya Formation are also found in these regions.
Outcrops of the Koldenen-Temirskaya and Zharykskaya Formation on the Temir, Koldenen-Temir, and Kubley Rivers have provided a continuous section. This sequence contains late Coniacian, Santonian and early Campanian deposits.
Light green, fine grained sandstones and siltstones with a phosphoritic horizon make up the Coniacian interval. Lower Santonian intervals,

ranging from siltstones to fine grained sandstones, contain two phosphoritic horizons. Early Santonian belemnites of the *Goniocamax lundgreni uilicus* Zone and selachians of *Squalicorax santonicus* Zone and *Squalicorax paulovi* Zone are helpful to define this layer. Foraminifers of the *Stensioeina exculpta exculpta* Zone and *Stensioeina granulata perfecta* Zone indicate an early Santonian age. The late Santonian interval contains belemnites of the *Belemnitella praecursor praecursor* Zone, bivalves of the *Oxytoma tenuicostata* Zone, selachians of the *Squalicorax kaupi* Zone, and foraminifers of the *Gavelinella stelligera* Zone. Early Campanian contains belemnites of *Actinocamaax laevigatus-Belemnitella praecursor mucronatiformis* Zone, selachians of *Squalicorax lindstromi* Zone, foraminifers of *Gavelinella clementiana clementiana* Zone and *Bolivinoides decoratus decoratus* Zone.

Zharykskaya Formation in western Primugodzharie and Aktyubinskaian Priuralie, was deposited transgressively over the Koldenen-Temirskaya Formation. Rhythmically alternating layers (5-7 m thick) of silty, marly, dark grey to green-grey clays, and glauconite light grey, yellow grey siltstones with phosphoritic concretions, reach a thickness of 40 m in the Zharyskaya Formation (Zhelezko & Segedin 1972; Zhekezko 1988; Naidin *et al.* 1991). Rocks in the lower portion contain early Campanian belemnites of the *Belemnellocamax mammilatus-Belemnitella mucronata alpha* Zone; selachians of the *Squalicorax plicatus* Zone and foraminifers of the *Cibicidoides temirensis* Zone. The upper portion of the formation contains late Campanian belemnites of the *Belemnitella mucronata mucronata* Zone, foraminifers of *Brotzenella montereleusis* Zone and *Cibicidoides voltzianus* Zone.

The late Campanian Kursayskaya Formation in the western Primugodzharie and Aktyubinskian Priuralie transgressively lies on the Zharykskaya Formation. The Kursayskaya Formation is composed of calcareous light-yellow-grey siltstones, silty marls with isolated phosphoritic concretions, as well as phosphoritic horizon toward the base of the formation, with a thickness of 15 m. Late Campanian belemnites of the *Belemnitella* ex gr. *langei* Zone, mollusca of the *Inoceramus balticus* Zone, selachians of the *Squalicorax* ex gr. *pristodontus* Zone, foraminifers of the *Bolivina kalinini* Zone and *Brotzenella taylorensis* Zone are found in this area (Zhelezko & Segedin 1972; Zhelezko 1988; Naidin *et al.* 1991).

In the eastern margin of the PriCaspian Zone, Santonian marine deposits, mixed with Campanian deposits, are widespread. The Santonian deposits can be divided into lower and upper units. The lower Santonian sediments are 10-50 m of light grey, green-grey, blue grey sandy limestones, with rare phosphoritic concretions. Interlayers of calcareous sands and chalk-like, clayey limestones are also present. There are belemnites of the *Goniocamax lundgreni uilicus* Zone (early Santonian), selachians of *Squalicorax santonicus* Zone (early Santonian), selachians of *Squalicorax papulovi* Zone (early-middle Santonian); foraminifers of *Stensioeina exculpta exculpta* Zone (early Santonian or late Coniacian-Early Santonian). The upper Santonian sediments range in thickness from 5-35 m and are light grey, green-grey, blue-grey sandy clays and limestones, with rare phosphatic and pyritic concretions. There are belemnites of *Belemnitella praecursor praecursor* Zone (late Santonian); mollusca of the *Oxytoma tenuicostata* Zone (late Santonian); selachians of the Late Santonian *Squalicorax kaupi* Zone; foraminifers of *Gavelinella stelligera* Zone (late Santonian or late Santonian-early Campanian).

The Campanian deposits of the Eastern PriCaspian Zone are divided into lower and upper sedimentary units. Lower Campanian sediments (5-30 m) are light grey, chalk-like limestones, marls, calcareous clays with belemnites of *Actinocamax laevigtus-Belemnitella praecursor mucronatiformis* Zone (early Campanian), *Belemnellocamax mammilatus-Belemnitella mucronata alpha* Zone (early Campanian); selachians of *Squalicorax lindstromi* Zone (early Campanian), *Squalicorax plicatus* Zone (early Campanian); and foraminifers of *Gavelinella clementiana clementiana* Zone (early Campanian), *Bolivinoides decoratus decoratus* Zone (early Campanian), *Cibicidoides temirensis* Zone (early Campanian). Upper Campanian sediments are light green to grey, sandy marls, clayey chalk and range in thickness 5-30 m. There are belemnites of *Belemnitella mucronata mucronata* Zone (late

Campanian), *Belemnitella* ex gr. *langei* Zone (late Campanian), foraminifers of *Brotzenella monterelensis* Zone (late Campanian), *Cibici-doides voltzianus* Zone (late Campanian), *Bolivina kalinini* Zone (late Campanian), and *Brotzenella taylorensis* Zone (late Campanian) (Naidin *et al.* 1991)

Santonian-Campanian marine rocks in the northern portion of PriAralie and southern Turgay are transgressively laid on continental Turonian-Coniacian deposits (Papulov & Naidin 1979). The lower units have a thin layer (1-2 m) of conglomerate which contains sands, phosphoritic concretions, pebbles of argillites, mollusca, shark teeth, silicified wood, cemented with calcareous clay. Santonian deposits include marine sands with gravel and phosphoritic concretions. Mollusca of the late Santonian age, *Oxytoma tenuicostata* Zone; selachians of *Squaliconax kaupi* Zone. Campanian deposits are represented by the calcareous clays and marls with belemnites of *Belemnitella mucronata* Schloth., *s.l.*; foraminifers of Early Campanian *Cibicidoides temirensis* Zone which resembles the Early Campanian Zones of the Mangyshlak and PriCaspian depressions.

In the Turgay Trough, the Santonian-Campanian sediments are represented by the Eginsayskaya and Ayatkaya Formations. Thickness and position of these deposits are dependant on the relief on which they were lain and the dynamics of coastal marine deposition. The Eginsayskaya Formation ranges, in thickness from 5-150 m, is widespread reflecting coastal, shoreline and lagoonal deposits. The Ayatskaya Formation is found only in isolated areas (Ayat river near Taranovskoe, Sokolovsky and Sarbaysky quarries near Rudnyi city in Kustanay area) and reflects lagoonal sediments that are gradually replaced by the marine rocks of the Eginsayskaya Formation.

The Eginsayskaya Formation is best exposed in the Kachar quarry (Fig. 6). The Novokozyrevskaya Formation overlies continental Jurassic deposits. The formation is Ceno-manian in age, determined by spores and pollen. The sedimentary rocks include interlayering of grey-pink clays, multicolored silty clays, silty bauxite, black and brown lignite, and viscous grey clays. The total thickness is 11.3 m.

An unnamed 15.8 m group of rocks overlies the Novokozyrevskaya Formation. It is analogous to the Kuznetsovskaya Formation of West Siberia. Spores and pollen give this group an age of Turonian. The sedimentary rocks include laminated, yellow-grey, quartz rich medium grained sandstones and yellow-grey silty clays. This group is terminated by a stratigraphic unconformity.

The Eginsayskaya Formation is composed of both Santonian and Campanian rocks. The Santonian Eginsayskaya Formation is confirmed by several fossil groups. A 5.3 m thick horizon of dark-grey platy clays with interlayering of glauconite quartzeous siltstones and concretions of siderite uses pollen and spores. A 3.3 m horizon of green-grey siltstones and sandstones has evidence from cephalopods (*Baculites*), bivalves (*Trigonia*), selachian, spores and pollen. Spores and pollen are used in a 3.1 m thick horizon of dark-grey, black solid silty clays. A 4.1 m thick horizon of green-grey clayey quartz-glauconite sandstones and siltstones, with interlayers of sandy dark-grey clays, are in the *Ammobaculites dignus-Pseudoclavulina hasttata admota* foraminifer Zone and are found along with selachian, spores and pollen.

In the Maastrichtian Zhuravlevskaya Formation cephalopods (belemnites) and foraminifera (*Gaudryina rugosa spinulosa* assemblage) are present. Interlayering of silicified calcareous siltstones and opokas (siliceous mudstones) are found throughout its thickness of 6.0 m. A sandy marl with a thickness of 5.0 m contain cephalopods (belemnites) and foraminifera of *Spiroplectammina kasanzevi* assemblage. Marine Palcogene deposits lie conformably above the Zhuravlevskaya Formation.

The Ayatskaya Formation lies on 0.6-3 m of conglomerates and sandstones. Deposits up to 7 m are dark-grey, green-grey glauconite quartz rich siltstones with spores and pollen, indicating an early Santonian age. Mollusca from the *Inoceramus cardissoides* Zone (early Santonian) are found in coarse glauconite sandstones with beidellite-montmorillonite-halloysite clays with sideritic and iron-ore concretions (1.5-5 m). This is followed by 2 m of green grey to yellow siltstones and fine grained poorly cemented sandstones and 1.5 m of dark beidellite-montmorillonite-halloysite clays with gypsum,

siderite and iron ore concretions. A red to yellow brown, yellow green oolitic iron ores in sands and clays is approximately 1-2 m just before a stratigraphic unconformity. Campanian sediments of fine to medium grained diagonally bedded sandstones with mollusca make up 2 m. It contains late Campanian fossils of *Pycnodonta* sp., *P.* cf. *hippopodium*, *Acutostrea* cf. *acutirositris*, *Inoceramus* sp., *I.* cf. *balticus* and foraminifers of *Spiroplec-tammina optata* Zone.

Santonian interval contains the spores and pollen of SPA IV; foraminifers of *Ammobaculites dignus-Pseudoclavulina hastata admota* Zone, as well as the bivalves of Turgayan *Inoceramus cardissoides* Zone (early Santonian) and selachians of *Squalicorax santonicus* Zone and *Squalicorax papulovi* Zone (early Santonian), selachians of *Squalicorax kaupi* Zone. Campanian interval contains the spores and pollen association SPA IV.5; selachians of *Squalicorax lindstromi* Zone (early Campanian); *Squalicorax plicatus* Zone (early Campanian); *Squalicorax* ex gr. *pristodontus* Zone (late Campanian); radiolarians of *Prunobrachium crassum* Zone (early Campanian), *Amphipyndax stocki* Zone (late Campanian); foraminifers of *Spiroplectammina senonana pocurica* Zone (early Campanian); *Spiroplectammina optata* Zone (late Campanian), *Bolivina kalinini-Brotzenella taylorensis* Zone (late Campanian) (Amon 1987).

MAASTRICHTIAN (Figs 3-6)

The western portion of the Primugodzharie and Aktyubinskian Priuralie marine deposits of Maastrichtian age are represented by a calcareous clay marl of the Zharskaya Formation. A total thickness of 15 m of light grey siltstones and marls contain phosphoritic concretions throughout the deposit. Marls in the lower part of the section contain belemnites of *Belemnella lanceolata* Zone, *Belemnella sumensis sumensis* Zone, *Belemnella sumensis pristodontus* Zone; it contains also foraminifers of *Angulogavelinella gracilis* Zone, *Brotzenella complanata* Zone and *Bolivinoides draco draco* Zone. Marls of the upper part of the formation contain belemnites of *Neobelemnella kazimiroviensis* Zone; mollusca of *Oxytoma danica* Zone and *Pseudotextularia elegans* Zone.

In the eastern margin of the eastern PriCaspian Zone, Maastrichitian deposits are widespread. The early Maastrichtian sediments are transgressively occurring on Campanian rocks and composed of chalk, chalky limestone with belemnites of *Belemnella lanceolata* Zone, *Belemnella sumensis sumensis* Zone; foraminifers of *Angulo-*

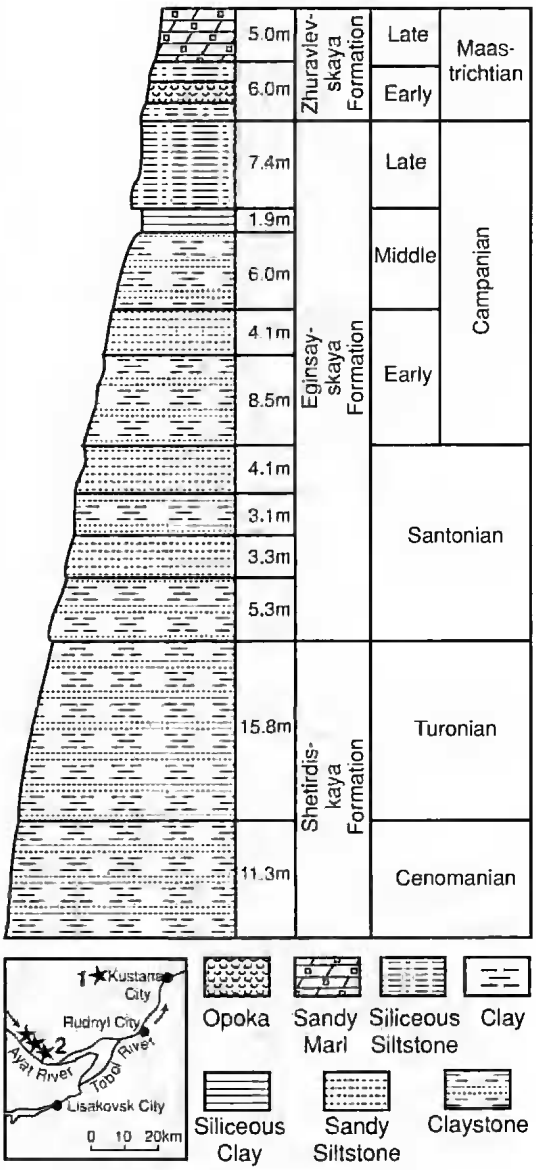


FIG. 7. — Columnar section of the Kachar quarry reference section.

*gavelinella gracilis* Zone; *Brotzenella complanata* Zone and *Bolivinoides draco draco* Zone; thickness is 30-60 m. Upper Maastrichtian sediments, ranging from 12-80 m thick, are represented by the same rocks with belemnites of *Neobelemnella kazimiroviensis* Zone; mollusca of *Oxytoma danica* Zone; foraminifers of *Brotzenella praeacuta* Zone, *Pseudotextularia elegans* Zone (Naidin *et al.* 1991).

In northern PriAralie and south-western Turgay, Maastrichtian deposits are transgressively deposited on Santonian-Campanian rocks or Paleozoic rocks. They are represented by marls, chalks, clayey siltsrones, calcareous siltstones, sands and sandstones, cemented by calcareous clay. Mollusca, belemnites and brachiopods can be found within the 30-50 m thick formation. Early Maastrichtian deposits contain belemnites of *Belemnella lanceolata* and foraminifers of *Gaudryina rugosa spinulosa* Zone. The foraminifera zone can be correlated to deposits in the Magyshlak and PriCaspian depression. The Late Maastrichtian deposits contain belemnites of the *Neobelemnella kazimiroviensis* Zone and foraminifers of *Spiroplectammina kasanzevi* Zone, which can also be correlated to the Magyshlak and PriCaspian depression.

In the Turgay area, the Maastrichtian deposits include calcareous sandstones and silty clays, calcareous siltstones, marl, quartz-glauconite sands and sandstones of the Zhuravlevskaya Formation. This formation ranges in thickness from 5-85 m and is rarely found in outcrops except in the river valleys of the western portion of the Turgay trough. The Kachar quarry (Fig. 7) and Ayat River sections are the best reference sections. Thick Paleogene deposits cover most of the Zhuravlevskaya Formation.

The Zhuravlevskskaya Formation contains early Maastrichtian spores and pollen of the SPA IV.6 and rare belemnites of the early Maastrichtian *Belemnella sumensis* Zone. Mollusca of the *Oxyroma uralica* Zone is found in the north-eastern portion of the Turgay trough. Radiolarians of the *Orbiculiforma renillaeformis* Zone and foraminifers of the *Gaudryina rugosa* Zone reflect early Maastrichtian.

Late Maastrichtian intervals contain belemnites of *Neobelemnella kazimiroviensis* Zone, foraminifers of *Brotzenella praeacuta* Zone and *Hanzawaia ekblomi* Zone (late Maastrichtian) (Amon 1987).

## SUMMARY

During the Cretaceous, microfossils are important to correlate on a global and interregional scale, especially in the Peri-Tethys area (Amon & De Wever 1994). The correlation proposed by Koch (1977) is mainly valid for western and north-western Europe. The zonal scale based on ammonite and belemnite zonation is only valid for European Russia, Ukraine, Byelorussia, Moldavia, and southern adjacent countries (Zhamoida 1989, 1994). The zonation shown in figures 5 and 6 can be used in the southern Urals to help correlate to the East European platform during the Cretaceous. The regional stratigraphy and correlation are summarized in figures 3 and 4.

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## APPENDIX

### CONTENT OF BIOSTRATIGRAPHIC ZONES

#### BELEMNITES

- *Neobelemnella kazimiroviensis* Zone: *Neobelemnella kazimiroviensis* (Skolozdr.), *Belemnella* sp., *B. sumensis sumensis* Jel., *B. sumensis praearkhangelskii* Naid.
- *Belemnella sumensis sumensis* Zone: *Belemnella* sp., *B.* ex gr. *sumensis* Jel., *B. sumensis sumensis* Jel., *B.* ex gr. *lanceolata* (Schloth.).
- *Belemnella lanceolata* Zone: *Belemnella* sp, *B.* ex.gr. *lanceolata* (Schloth.), *B. lanceolata* (Schloth.), *B.* ex gr. *sumensis* Jel.
- *Belemnella licharevi* Zone: *Belemnella* sp., *B. licharevi* Jel.
- *Belemnitella* ex gr. *langei* Zone: *Belemnitella* ap., *B. langei langei* Schatsk., *B. langei minor* Jel., *B. langei najdini* Kon.
- *Belemnitella mucronata mucronata* Zone: *Belemnitella* sp., *B* ex gr. *mucronata* (Schloth.), *B. mucronata mucronata* (Schloth.) Arkh.
- *Belemnellocamax mammilatus-Belemnitella mucronata alpha* Zone: *Actinocamax* sp., *Belemnellocamax mammilatus* (Nilss.), *Paractinocamax* ex gr. *grossouvrei* (Janet.), *Belemnitella* sp., *B. mucronata mucronata* (Schloth.), *B. mucronata alpha* Schatsk.
- *Actinocamax laevigatus-Belemnitella praecursor mucronatiformis* Zone: *Actinocamax* sp., *A. laelligatus* Arkh., *Paractinocamax* ex gr. *grossouvrei* (Janet.), *Belemnitella* sp., *B. praecursor media* Jel., *B. praecursor mucronatiformis* Jel.
- *Belemnitella praecursor praepraecursor* Zone: *Actinocamax* sp., *A.* ex gr. *verus* Mill., *A. verus fragilis* Arkh., *Belemnitella* sp, *B.* ex gr. *praecursor* Stoll., *B. praecursor praepraecursor* Naid., *B. praecursor media* Jel.
- *Goniocamax lundgreni uilicus* Zone: *Actinocamax* sp., *A.* ex gr. *verus* Mill., *A. verus fragilis* Arkh., *Goniocamax* ap., *G. lundgreni uilicus* (Kolt.).
- *Goniocamax lundgreni lundgreni* Zone: *Goniocamax* sp., *G. intermedius* (Arkh.), *G.* ex gr. *lundgreni* (Stoll.), *G. lundgreni lundgreni* (Stoll.).
- *Goniocamax intermedius* Zone: *Goniocamax* sp., *G. intermedius* (Arkh.).

#### MOLLUSCA

- *Oxytoma danica* Zone: *Teniupteria argentea* (Conrad), *Oxytomadanica* (Ravn).
- *Oxytoma uralica* Zone: *Chlamys pulchellus* (Nilss.), *Pycnodontevesiculare* (Lam.), *Oxytoma uralica* Glazun.
- *Inoceramus balticus* Zone: *Inoceramus balticus* Boehm., *Pycnodontehippopodium* (Nilss.), *Acutostrea* aff. *acutirostris* (Nilss.), *Chlamys* spp., *Dianchora labiata* (Wahl.)
- *Inoceramus azerbaidjanensis* Zone: *Inoceramus* sp., *In. azerbaidjanensis* Aliev.
- *Oxytoma tenuicostata* Zone: *Sphenoceramus angustus* (Beyenburg), *S. papulovi* Arabekjan, *S.* cf. *lingua* (Goldf.), *Inoceramus cycloides* Wegner, *Oxytoma tenuicostata* (Roem.), *Pycnodonte vesiculare* (Lam.), *Gryphaeostrea lateralis* (Nilss.), *Lopha semiplana* (Sow.), *Acutostrea curvirotris* (Nilss.).

- *Inoceramus cardissoides* Zone: *Inoceramus cardissoides* Gold-F., *I. pachti* Arkh., *Korobkovitrigonia amudariensis* (Arkh.), *K. tobolica* Pojark., *Chlamys faujasi* (Deft.).
- *Inoceramus schloenbachi* Zone: *Inoceramus* sp., *I.* ex gr. *kleini* Muell., *I. shloenbachi* Bochm.
- *Inoceramus labiatus* Zone: *Inoceramus cuvieri* Sow., *I. labiatus* Schloth., *I. lamarcki* Park., *I. websteri* Mant., *Placenti cerasplacenta* Dckay, *P. arkhangelskii* Iljin, *Collignoniceras woolgari* Mant.
- *Kamaroites grossouvrei* Zone: *Kamaroites* sp., *K.* aff. *subtilis* (Iljin), *K. grossouvrei* (Sem.), *K. mediasiaticum* (Luppov), *Schloenbachia varians* (Sow.), *S. varians* cf. *febramata* (Sow.), *S. subvarians* Spath., *S. ventricosa* Stieler, *Sciponoceras baculoides* (Mant.), *Mantelliceras mantelli* (Sow.).
- *Oxytoma pectinata* Zone: *Inoceramus crippsi* Mant., *I. orbicularis* Muenst., *I. pictus* Sow., *I. orbicularis* Muenst., *Oxytoma pectinata* (Sow.), *Entoliuri orbiculare* (Sow.), *E. noetlingi* (Sob.), *Acutostrea delettrei* (Coq.), *Amphiodonte conicum* (Sow.).

SELACHIANS

- *Squalicorax pristodontus* Zone: *Squalicorax pristodontus* (Ag.), *Pseudocorax affinis* (Ag.), *Cretolamna borealis* Prim.
- *Squalicorax* ex gr. *pristodontus* Zone: *Squalicorax* ex gr. *pristodontus* (Ag.), *Pseudoisurus* ex gr. *laevis* Leriche.
- *Squalicorax plicatus* Zone: *Squalicorax plicatus* (Priem.), *Paraanacorax* ex gr. *obruchevi* Glueck., *Scapanorhynchus* ex gr. *raphiodon* (Ag.), *Rhaphiodiscus texanus* (Roem.).
- *Squalicorax lindstromi* Zone: *Acrolamna acuminata dilatata* Zhel., *Protolamna arcuata* (Woodw.), *Squalicorax lindstromi* (David), *Paraanacorax obruchevi* Glueck., *Eostriatolamia lerichei* Glueck. *et* Zhel.
- *Squalicorax kaupi* Zone: *Acrolamna acuminata* (Ag.), *Protolamna aduncata subrecta* Zhell., *Squalicorax kaupi* (Ag.), *Eostriatolemia segedini* Glueck. *et* Zhel., *E. venusta* (Leriche), *Scapanorhynchus raphiodon* (Ag.).
- *Squalicorax papulovi* Zone: *Squalicorax papulovi* Zhel., *Eostriatolamia aktobensis* Zhel., *Scapanorhynchus temirensis* Zhel., *Ptichocorax dolloi* (Leriche), *Ptychodus deccurrens* Ag.
- *Squalicorax santonicus* Zone: *Squalicorax santonicus* Glueck. *et* Zhel., *Ptychocorax dolloi* (Leriche), *Microanacorax praeyangaensis* Glueck., *Eostriatolamia* ex gr. *venusta* (Leriche), *Cretoxyrhina mantelli* (Ag.), *Pseudocorax laevis* Leriche.
- *Squalicorax falcatus* Zone: *Squalicorax falcatus* (Ag.), *Microanacorax* ex gr. *praeyangaensis* Glueck., *Eostriatolamia* ex gr. *venusta* (Leriche), *Ptychodus* ex gr. *venusta* Dixon.
- *Squalicorax sagisicus* Zone: *Cretilamna appendiculata* (Ag.), *Squalicorax sagisicus* Glueck., *Acrolamna* ex gr. *crassicornis* Zhel.
- *Palaeoanacorax intermedius* Zone: *Paleoanacorax intermedius* Glueck., *Eostriatolamia* ex gr. *augustidens* (Ag.), *Scapanorhynchus* ex gr. *raphiodon* (Ag.).
- *Palaeoanacorax obliquus* Zone: *Paleoanacorax obliquus* (Reuss.), *Pseudoisurus semiplicatus* (Ag.), *Eostriatolamia* ex gr. *subulata* (Ag.), *Cretoxyrhina basalis* (Giebel.).
- *Palaeoanacorax volgensis* Zone: *Paraisurus macrorhizus* (Pict. *et* Camp.), *Cretodus suloatus* (Gein.), *Cretoxyrhina denticulata* Glueck., *Palaeoanacorax volgensis* Glueck., *Hispidaspis gigas* (Woodw.).

FORAMINIFERA

Maastrichtian, Late 2

- *Pseudotextularia elegans* Zone: *Cibicidoides clipeatus* (Vass.), *Gavelinella danica* (Brotz.), *Hanzawaia ekblomi* (Brotz.), *Pseudotextularia elegans* Rzeh., *Pseudotextularia varians* Rzeh.

Maastrichtian, Late 1

- *Brotzenella praeacuta* Zone: *Anomalinoides pinguis* (Jenn.), *Brotzenella praeacuta* (Vass.), *Cibicides kurganicus* Neck., *Gavelinella midwayensis* (Plumm.), *Gavelinella pertusa* (Marss.), *Gavelinella welleri* (Plumm.), *Globigerinelloides subcarinatus* (Bronn.), *Gyroidinoides globosus* (Hag.), *Pseudouvigerina cristata* (Marss.), *Tappania seulmensis* (Cushm.).

Maastrichtian, Late, PriAralie

- *Spiroplectammina kasanzevi* Zone: *Anomalinbides justus* Podob., *Brotzenella pseudopapilosa* (Cars.), *Bulimina rosenkrantzi* Brotz., *Heterostomella foveolata* (Marss.), *Quinqueloculina fusiformis* Putrja, *Spiroplectammina kasanzevi* Dain.

Maastrichtian, Late 2, Turgay

- *Hanzawaia ekblomi* Zone: *Spiroplectinella sengibabensis* (Bala-khm.), *Gaudryina gigantica* Subb., *Angulogavelinella caucasica* (Subb.), *Hanzawaia ekblomi* (Brotz.), *Karreria fallax* Rzeh., *Bulimina eminenta* Ehrem., *Gueblerina robusta* De Klasz.

Maastrichtian, Late 1, Turgay

- *Brotzenella praecuta* Zone: *Spiroplectammina kasanzevi* Dain, *Arenobulimina oblique* (Orb.), *A. presli* (Reuss), *Gaudryina rugosa rossica* Balakhm., *Gaudryinopsis subbotinae* (Kypr.), *Neoflabellina reticulata* (Reuss), *Valvulineria procera* Podobina, *V. imitata* Olss., *Gavelinella midwayensis* (Plumm.), *Cibicidoides bembix kazakhstanica* Neck., *Brotzenella praeacuta* (Vass.), *Anomalinoides pinguis pinguis* (Jenn.), *Nonionella kalinini* Volosh., *Reussella cimbrica* (Troels.), *R. bacillura* Ehrem., *Bolivina incrassata gigantea* Wicher, *Bolivinoides peterssoni* (Brotz.), *Rugoglobigerina rugosa* (Plumm.), *R. macrocephala* Broun., *Globotruncana havanensis* (Voorw), *Tritinella scotti* Bronn., *Heterohelix navarroensis* Loebl., *Pseudoguem-bellina kempensis* Esker, *P. palperba* Bronn. *et* Brown.

Maastrichtian, Early 3

- *Bolivinoides draco draco* Zone: *Bolivinoides draco draco* (Marss.),*Coleites crispus* Vass., *Gavelinella midwayensis* (Plumm.), *Rugoglobigerina rugosa* (Plumm.), *Spiroplectammina suturalis* Kal.

Maastrichtian, Early 2

- *Brotzenella complanata* Zone: *Angulogavelinella* ex gr. *caucasica* (Subb.), *Anomalinoides ukrainious* (Wolosch.), *Biglobigerinella biforaminata* (Hofk.), *Bolivina inorassata crassa* Vass., *Brotzenella complanata* (Reuss), *Gavelinella welleri* (Plumm.).

Maastrichtian, Early 1

- *Angulogavelinella gracilis* Zone: *Angulogavelinella gracilis stellaria* (Vass.), *Bolivina decurrens* (Ehr.), *Bolivinoides delicatulus* Cushm., *Bolivinoides peterssoni* Brotz., *Brotzenella taylorensis* (Cars.), *Cibicidoides bembix* (Marss.), *Gyroidinoides globosus* (Hag.), *Neflabellina praereticulata* Hilt., *Neflabellina reticulata* (Reuss), *Osangularia navarroana* (Cushm.).

Maastrichtian, Early, PriAralie

- *Gaudryina rugosa spinulosa* Zone: *Ataxophragmium rimosum* (Marss.), *Bulimina quadrata* Plumm., *Cibicidoides aktulagayensis* (Vass.), *C. spiropunctatus* (Gall. *et* Morr.), *C. bembix bembix* (Marss.), *Dorothia pupoides ovata* Podobina, *Gaudryina rugosa spinulosa* Neck., *Siphogaudryina stephensoni distincta* Podobina, *Spiroplectammina kelleri* Dain, *Spiroplectammina variabilis* Neck., *S. kelleri* Dairi, *Valvulineria imitata* Olss.

Maastrichtian, Early, Turgay

- *Gaudryina rugosa spinulosa* Zone: *Spiroplectammina brevis modesta* Kiss., *Spiroplectinella variaspera* (Kiss.), *S. baudouiniana* (Orb.), *Gaudryina rugosa spinulosa* Neck., *Siphogaudryina stephensoni* Cushm., *Quinqueloculina stolley* Brotz., *Lagena* spp., *Guttulina* spp., *Discorbis parvus* Ehrem., *Angulogavelinella gracilisstellaria* Vass., *A. praecaucasica* (Vass.), *Valvulineria lenticula* (Reuss), *Stensioeina pommerana* Brotz., *Gyroidinoides turgidus* (Hag.), *G. beresoviensis* (Balakhm.), *Osangularia navaroana* (Cushm.), *Gavelinella welleri* (Plumm.), *G. mira* Podob., *Cibicidoides voltzianus* (Orb.), *C. spiropunctatus* (Gall. *et* Morr.), *C. bembix* (Marss.), *Brotzenella complanata* (Reuss.), *B. menneri* (Kell.), *Heterolepa orcina* (Vass.), *Cibicides globigeriniformis* Neck., *C. gankinoensis* Neck., *C. kurganicus* Neck., *Nonionellina* spp., *Rheinholdella brotzeni* Olss., *Epistomina fax* Nauss, *Praebulimina carseyae* (Plumm.), *Bulimina* spp., *Bolivina incrassataincrassata* Reuss, *B. decurrens* (Ehrenb.), *Bolivinoides decoratusdracoformis* Vass., *B. draco miliaris* Hilt. *et* Koch., *B. senonicus* Dain, *Pullenia kazakhstanica* Dain, *P. americana* Cushm., *Quadrimorphina allomorphinoides* (Reuss).

Campanian, Late 4

- *Brotzenella taylorensis* Zone: *Bolivina incrassata incrassata* Reuss, *Bolivinoides giganteus* Hilt. *et* Koch, *Brotzenella taylorensis* (Cars.), *Globotruncana arca* (Cushm.), *G. morozovae* Vass., *Gyroidinoides turgidus* (Hag.), *Heterostomella praefoveolata* Mjatl., *Orbignyna inflata* (Reuss), *O. acheri* (Reuss), *Pseudouvigerina cristata* (Marss.), *Rugoglobigerina kelleri* (Subb.). *Stensioeina pommerana* Brotz.

Campanian, Late 3

- *Bolivina kalinini* Zone: *Bolivina kalinini* Vass., *Bolivinoides decoratus dracoformis* Vass., *B. miliaris* Hilt. *et* Koch, *Eponides frankei* Brotz., *Gavelinella cayeuxi mangyschlakensis* (Vass.), *Gemelliides orcinus* (Vass.), *Globotruncana majzoni* Sig. *et* Deb., *G. ventricosa* White, *Rugoglobigerina rugosa* (Plumm).

Campanian, Late 2

- *Cibicidoides voltzianus* Zone: *Cibicidoides voltzianus* (Orb.), *Gavelinella clementiana laevigata* (Marie), *Globorotalites* emdyensis Vass., *Globotruncana morozovae* Vass., *Heterostomella praefoveolata* Mjatl., *Plectina ruthenica* (Reuss), *Sitella laevis* (Beiss.)

Campanian, Late 1

- *Brotzenella monterelensis* Zone: *Ataxophragmium crassum caspium*Vass., *Brotzenella nienneri* (Kell.), *Brotzenella monterelensis* (Marie), *Cibicidoides aktulagayensis* (Vass.), *Globatruncana linneiana* (Orb.), *Haterostomella praefoveolata* Mjatl., *Orbignyna sacheri* (Reuss), *Sitella carseyae* (Plumm.), *Voloshinovella lafittei* (Marie).

Campanian, Late, PriAralie

- Cibicidoides aktulagayensis Zone: *Ataxophragmium crassum caspium* Vass., *Orbignyna ovata* Hag., *Voloshinovella laffittei* (Marie), *Heterostomella praefoveolata* Mjatl., *Eponides biconvexus* Marie, *E. frankei* Brotz., *Gavelinella clementiana laevigata* (Marie), *Brotzenella monterelensis* (Marie), *B. taylorensis* (Cars.), *Cibicidoides aktulagayensis* (Vass.), *Globotruncana arca* (Cushm.), *G. morozovae* Vass., *Pseudcuvigerina cristata* (Marss.), *Rugoglobigerina kelleri* (Subb.), *Bolivina kalinini* Vass.

Campanian, Late 2, Turgay

- *Bolivina kalinini-Brotzenella taylorensis* Zone: *Spiroplectammina variabilis* (Neck.), *Plectina ruthenica* (Reuss), *Ataxophragirium compactum* Brotz., *A. spongiosum* Kriv. *A. crassum caspium* Vass., *Orbignyna inflata* (Reuss), *O. sacheri* (Reuss), *Arenogaudryina granosa* Podobina, *Nodosaria* spp., *Dentalina* spp., *Valvulinoides umovae* (Kypr.), *Globorotalites emdyensis* Vass., *G. michelinianus* (Orb.), *Gyroidinoides obliquaseptatus* (Mjatl.), *Eponides biconvexus* Marie, *Eponidella* linki Wick., *Gavelinella clementiana* (Orb.) *s.l.*, *Brotzenella taylorensis* (Carsey), *Anomalinoides falsiplanctonicus* (Balakhm.), *Bolivina kalinini* Vass., *B. plaita* Carsey, *Bolivinoides decoratus decoratus* (Jones), *B. laevigatus* Marie, *Globigerinelloides asper* (Ehrenb.), *Heterohelix globulosa* (Ehrenb.).

Campanian, Late 1, Turgay

- *Spiroplectammina optata* Zone: *Bathysiphon vitta* Nauss, *Thurammina papillata* Brady, *Ammodiscus glabratus* Cushm. *et* Jarv., *Haplophragmoides ruidus crispus* Podobina, *H.* cf. *idonensis* Podobina, *Haplophragmium planum* (Belous.), *Spiroplectammina brevis* Kiss., *S. multiversurata* Kiss., *S. kelleri* Dain, *S. optata* Kiss., *Bolivinopsis rosula* (Ehrenb.), *Dorothia pupoides* (Orb.), *Ataxophragmium rimosum* (Marss.), *Valvulineria laevie* Brotz., *Gyroidinoides umbilicatulus* (Orb.), *Osangularia cordieriana* (Orb.), *Eponides sibiricus* Neck., *Cibicidoides eriksdalensis* Brotz., *C. aktulagayensis* (Vass.), *Brotzenella monterelensis* (Marie), *Anomalinoides pinguis neckayae* Vass., *Allomorphina nonioninoides* Dain.

Campanian, Early 3

- *Cibicidoides temirensis* Zone: *Bolivinitella galeata* Vass., *Bolivinoides decoratus decoratus* Jon., *Bolivinoides laevigatus laevigatus* Marie, *Cibicidoides aktulagayensis* (Vass.), *Cibicidoides montanus* (Dol.), *Cibicidoides temirensis* (Vass.), *Eponides biconvexus* Marie, *Gavelinella dainae* (Mjatl.), *Gavelinella stelligera* Marie, *Osangularia cordieriana* (Orb.), *Plectina convergens* (Kell.), *Stensioeina pommerana* Brotz.

Campanian, Early 2

- *Bolivinoides decoratus decoratus* Zone: *Biglobigerinella algeriana* Sig. *et* Ten Dam, *Bolivinoides decoratus decoratus* Jon., *Bolivinoides granulatus* Hofk., *Eponides moskvini* (Kell.), Gavelinella *clementiana pseudoexcolata* (Kal.), *Globigerinalloides volutus* (White), *Orbignyna irreperta* Wolosch.

Campanian, Early 1

- *Gavelinella clementiana clementiana* Zone: *Bolivinoides laevigatus finitimus* Vass., *Dorothia pupoides* (Orb.), *Neoflabellina rugosa* (Orb.), *Gavelinella clementiana clementiana* (Orb.), *Gavelinella dainae* (Mjatl.), *Globigerinelloides asper* (Ehr.), *Globigerinelloides clavatus* Bronn., *Globotruncana arca* (Cushm.), *Neoflabellina rugosa* (Orb.), *Reussella pseudospinulosa* Troels., *Stensioeina pommerana* Brotz.

Campanian, Early PriAralie

- *Cibicidoides temirensis* Zone: *Ataxophragmium orbignynaeformis* Mjatl., *Stensioeina mursatacnsis* Vass., *S. pommerana* Brotz, *Eponides moskvini* (Keller), *Osangularia cordieriana* (Orb.), *Gavelinella costulata* (Marie), *G. dainae* (Mjatl.), *G. clementiana pseudoexcolata* Kalin., *Cibicidoides temirensis* (Vass.), *Bolivinoides decoratus decoratus* Jon., *B. laevigatus laevigatus* Marie, *Bolivinitella galeata* Vass.

Campanian, Early Turgay

- *Spiroplectammina senonana pocurica* Zone: *Rhabdammina cylindrica* (Glaessn.), *Bathysiphon nodosariaformis* Subb., *Thurammina splendens* Egger, *T. porosa* Egger, *Glomospira corona* Cushm. *et* Jary., *G. gordialiformis* Podob., *Reophax proprius* Podob., *R. angustus* Belous., *Adercotryma glomeratoformis* (Zasp.), *Haplophragmoides giganteus* Belous., *Cribrostomoides cretaceus exploratus* Podob., *C. trinitatensis sibiricus* Podob., *Labrospira fraseri propensa* Podob., *Ammobaculites fragmentarius* Cushm., *Ammomarginulina crispa* (Kypr.), *Spiroplectammina senonana pocurica* Balakhm., *Trochammina boehmi* Franke, *Gaudryinopsis vulgaris* (Kypr.), *Pseudoclavulinia bastata admota* Podob.

Santonian, Late

- *Gavelinella stelligera* Zone: *Ataxophragmium orbignynaeformis* Mjatl., *Bolivinoides strigillatus* (Chapm.), *Cibicides excavatus* Brotz., *Cibicidoides eriksdalensis* (Brotz.), *Gavelinella costulata* (Marie), *G.* ex gr. *stelligera* (Marie), *G. stelligera* (Marie), *G. umbilicatula* (Mjatl.), *Globorotalites michelinianus* (Orb.), *Globotruncana bulloides* Vogl., *Osangularia whitei crassa* (Vass.), *O. whitei polycamerata* (Vass.), *O. whitei praeceps* (Brotz.), *O. whitei whitei* (Brotz.), *Praebulimina ventricosa* Brotz., *Spiroplectam-mina rosula* (Ehr.), *Stensioeina exculpta exculpta* (Reuss), *Stensioeina exculpta gracilis* Brotz., *S. granulata perfecta* Koch, *Valvulineria mariei* Vass.

Santonian, Turgay

- *Ammobaculites dignus-Pseudoclavulina bastata admota* Zone: *Rhizammina* sp., *Bathysiphon vitta* Nauss, *Psammosphaera laevigata* White, *Saccammina* spp., *Ammodiscus cretaceus* (Reuss), *Reophax inordinatus* Young, *R. guttiformis* Podob., *Haplophragmoides tumidus* Podob., *H. eggeri* Cushm., *Cyclammina flexuosa* Podob., *Labrospira* spp., *Ammobaculites dignus* Podob., *Ammosealaria incultus* (Ehrenb.), *Pseudoclavulina* sp., *P. bastata admota* Podob.

Santonian, Early 2

- *Stensioeina granulata perfecta* Zone: *Cibicides excavatus* Brotz., *Cibicidoides eriksdalensis* (Brotz.), *Prkebulimina ventricosa* (Brotz.), *Spiroplectammina rosula* (Ehr.), *Stensioeina granulata incondita* Koch, *Stensioeina granulata perfecta* Koch, *Valvulineria mariei* Vass.

Santonian, Early 1, upper part of late Coniacian - lower part of early Santonian

- *Stensioeina exculpta exculpta* Zone: *Cibicidoides erikedalensis* (Brotz.), *Gaudryina laevigata* Franke, *Gavelinella infrasantonica* (Balakhm.), *Gavelinella umbilicatula* (Mjatl.), *Spiroplectammina rosula* (Ehr.), *Stensioeina exculpta exculpta* (Reuss), *Stensioeina granulata granulata* (Orb.).

Coniacian, Late 2

- *Stensioeina granulata granulata* Zone: *Eponides*

*concinnus planus* Vass., *Gavelinella costulata* (Marie), *G. infrasantonica* (Balakhm.), *G. thalmanni* (Brotz.), *Globorotalites michelinianus* (Orb.), *Osangularia whitei whitei* (Brotz.), *Spiroplectammina embaensis* Mjatl., *Stensioeina granulata granulata* (Orb.), *Valvulineria laevis* Brotz.

Coniacian, Late 1

- *Gavelinella costulata* Zone: *Gavelinella costulata* (Marie), *G. infrasantonica* (Balakhm.), *G. thalmanni* (Brotz.), *Osangularia whitei whitei* (Brotz.), *Bolivinita eleyi* (Cushm.), *Spiroplectammina embaensis* Mjatl., *Stensioeina granulata granulata* (Orb.)

Coniacian, Early

- *Gavelinella kelleri* Zone: *Bolivinita eleyi* (Cushm.), *Eponides concinnus* Brotz., *Gavelinella kelleri* (Mjatl.), *G. praeinfrasantonica* (Mjatl.), *Globotruncana renzi* Gand., *Gyroidinoides turgidus* (Hag.), *Reussella kelleri* Vass., *Stensioeina granulata kelleri* Koch, *Verneuilina muensteri* Reuss.

Coniacian, Turgay

- *Haplophragmium chapmani-Ammoscalaria antis-Reussella kelleri* Zone: *Ammobaculites dignus* Podob., *Ammobaculoides unicus* Tanach., *Ammoscalaria antis* Podob., *Haplophragmium chapmani* (Tapp.), *Spiroplectammina senonana orientalis* Kiss., *Trochammina boehmi* Franke, *T. arguta* Podob., *Discorbis sibiricus* Dain, *Reussella kelleri* Vass., *Eponides concinnus planus* Vass., *Gavelinella costulata* (Marie), *G. infrasantonica* (Balakhm.), *Heterohelix* spp.

Coniacian, Zauralie

- *Discorbis sibiricus* Zone: *Arenobulimina* sp., *Nodosaria* sp., *N. zippei* Reuss, *N. hastata* Schar., *Dentalina* sp., *D. basiplanata* Cushm., *D. tineaformis* Schar., *Discorbis* sp., *D. sibiricus* Dain, *Stensioeina emscherica* Baryschn., *Valvulineria lentioula* (Reuss), *Eponides* sp., *E. incognitus* Kypr., *E. karsteni* (Reuss), *Gavelinella infrasantonica* (Balakhm.), *G. praeinfrasantonica* (Mjatl.), *G. sibirica* Dain, *Cymbalopora martini* (Brotz.), *Reussella kelleri* Vass., *Praebulimina* sp., *Heterohelix* spp.

Coniacian, Early W Siberia

- *Haplophragmium chapmani-Ammoscalaria antis* Zone: *Ammobaculites dignus* Podob., *A. fragmentarius agglutinans* Podob., *Ammobaculoides unicus* Tanach., *Ammoscalaria antis* Podob., *Haplophragmium chapmani* (Tapp.), *Spiroplectammina senonana orientalis* Kiss.

Turonian, Late

- *Gavelinella moniliformis* Zone: *Ataxophragmium compactum* Brotz., *Gaudryina variabilis* Mjatl., *Gavelinella moniliformis* (Reuss), *Globorotalites multiseptus* (Brotz.), *Globotruncana lapparenti* Brotz., *G. marginata* (Reuss), *Hedbergella agalarovae* (Voss.), *Reussella carinata* Vass., *Spiroplectammina praelonga* (Reuss.).

Turonian, Late, W Siberia

- *Pseudoolavulina hastata hastata* Zone: *Ammoscalaria antis* Podob., *Haplophragmoides crikmayi* Stelk et Wall., *H. rota sibiricus* Zasp., *Pseudoclavulina hastata hastata* Cushm., *Textularia anceps* Reuss, *Trochammina arguta* Podob.

Turonian, Early, W Siberia

- *Gaudryinopsis filiformis angusta* Zone: *Ammobaculites tuaevi* Zasp., *Ammomarginulina haplophragoidaeformis* (Balakhm.), *Gaudryinopsis filiformis angusta* Podob., *Haplophragmium incomprehensis* (Ehrem.), *Labrospira collyra* (Nauss.), *Lituotuba confusa* Zasp., *Trochammina subbotinae* Zasp., *Uvigerinammina manitobensis* (Wick.).

Cenomanian, Upper, W Siberia

- *Trochammina wetteri-Trochammina subbotinae* Zone: *Ammobaculites tuaevi* Zasp., *Neobulimina subcretacea* (Cushm.), *Reophax inordinatus* Young, *Saccammina scruposum* Berth., *Thurammina papillata* Brady, *Trochammina subbotinae* Zasp., *T. wetteri* Stelk & Wall, *Uvigerinammina manitobensis* (Wick.).

Cenomanian, Lower and Middle

- *Gavelinella cenomanica* Zone: *Gavelinella bal-*

*tica* (Brotz.), *G. cenomanica cenomanica* (Brotz.), *G. cenomanica concava* (Vass.), *Globigerinelloides bentonensis* (Morr.), *G. ultramicrus* (Subb.), *Gyroidinoides nitidus* (Reuss), *G. subconicus* (Vass.), *Hagenowella chapmani* (Cushm.), *Hedbergella caspia* (Vass.), *Hoeglundina postdorsoplana* (Vass.), *Lingulogavelinella bilamellosa* (Balakhm.), *Valvulineria lenticula lenticula* (Reuss), *V. lenticula plummerae* Loett.

## RADIOLARIA

Turgay

- *Orbiculiforma renillaeforniis* Zone: *Orbiculiforma renillaeformis* (Camp. *et* Clark), *O. australis* Pess., *O. regis* Pess., *Crucella espartoensis* Pess., *Tholodiscus fresnoensis* (Forem.), *Stichocapsa asymbatos* (Forem.), *Dictyomitra* spp.
- *Amphipyndax stocki* Zone: *Spongotrochus morenoensis* Camp. *et* Clark, *Orbiculiforma maxima* (Lipm.), *Phaseliforma subcarinata* Pess., *Patellula verteroensis* (Pess.), *Amphibrachium mucronatum* Lipm., *Prunobracchium articulatum* (Lipm.), *Amphimenium sibiricum* Lipm., *Theocampe sibirica* Lipm., *Amphipyndax stocki* (Camp. *et* Clark), *Dictyomitra* spp., *Lithostrobus rostovzevi* Lipm.
- *Prunobrachium crassum* Zone: *Spongopyle insolita insolita* Kozur., *Spongotrochus polygonatus* (Camp. *et* Clark), *Prunobrachium crassum* (Lipm.), *Amphibrachium ornatum* Lipm., *Porodiscus cretaceus*. Camp. *et* Clark, *Botryometra amazon* (Forem), *Throcampe animula* (Gorb.), *Immersothorax marinas* (Gorb.), *Dictyomitra* spp., *Lithostrobus rostovzevi* Lipm.
- *Ommatodiscus mobilis* Zone: *Phaseliforma concentrica* (Lipm.), *Ommatodiscus mobilis* Kozl., *Spongodiscus* spp., *Orbiculiforma* spp., *O. multa* (Kozl.), *Stylarta longispina* Squin., *Dictyomitra striata* Lipm., *D. torquata* Forem.
- *Stichocapsa pyramidata* Zone: *Cenosphaera* sp., *C. magna* Grig., *Ellipsoxiphus asper* Ruest, *Trochodiscus spiniger* Lipm., *Spongodiscus* spp. *Orbiculiforma* spp. *Stylotrochus dolichacantus* Lipm., *Stichocapsa* sp., *St. pyramidata* (Grig.), *Dictyomitra* spp.
- *Cenodisous cenomanicus-Stichocapsa ferosia uvatica* Zone: *Cenodiscus cenomanious* Aliev, *Triadiscus lozyniaki* Amon, *Pentinastrum kurganicum* Amon, *Spongotripus aculeatus* Lipm., *Stichocapsa* sp., *St. ferosia uvatica* Amon, *Cryptamphorella conara* (Forem.), *Holocryptocanium barbui* Dumitrica.

## SPORES-POLLENS ASSOCIATIONS

Maastrichtian, SPA IV.6:

- dominants: *Pinaceae*, *Taxodiaceae*, *Nermapolles* Pf., *Trudopollis* Pf., *T. nonperfectus* Pf., *T. speciosus* Pf.;
- subdominants: *Gleichenidites* sp., *Pinus* sp., *P. aralica* Bolch., *Concavisporites* sp., *Matonisporites* spp., *Polypodiisporites* Ep., *Laevigatosporites* sp., *Cyathidites* sp., *Cedrus* sp., *Casuarinidites* sp., *Triorites* sp., *Triporopollenites* sp., *Betulaepollenites* sp., *Kuprianipollis* sp., *Oculopollis* sp., *Plicapollis sp.*;
- attendants: *Classopollis* sp., *Gnetaceapollenites* sp., *Ephedrites* sp., *Triporopollenites mutabilis* (N. Mtch.) Bratz., *T. radiatostriatus* (N. Mtch.), *Triatriopollenites exelsus* (R. Pot.), *T. rurensis* Pf., *Subtriporopollenites anulatus* Pf., *Vacuopollis* spp., *Nudopollis* Pf., *Extratriporopollenites* Pf., *Mancicorpus* N. Mtch., *Aquilapollenites* Rouse *et* N. Mtch., *Proteacidites* Cook. *et* Coup., *Triprojectus* N. Mtch.;
- microphytoplankton abundant.

Campanian, SPA IV.5:

- dominants: *Gleicheniidites senonicus* Ross., *G. laetus* (Bolch.) Bolch., *Plicifera delicata* (Bolch.) Bolch., *Pinus* sp., *P. aralica* Bolch.;
- subdominants: *Concavisporites* sp., *Matonisporites* sp., *Polypodiisporites* sp., *Laevigatosporites* sp., *Cyathidites* sp., *Ariadnaesporites verrucatus* (Elsik) Hills., *Cedrus* sp., *Casuarinidites* sp., *Triorites* sp., *Triporopollenites* sp.l *Betulaepollenites* sp., *Kuprianipollis* sp., *Trudopollis rector* Pf., *T. hemiperfectus* Pf., *T. parvotrudens* Pf., *T.* sp., *Oculopollis* sp., *Plicapollis serta* Pf., *P. conserta* Pf., *P.* sp.;
- attendants: *Appendicisporites* sp., *Cicatricosisporites* sp., *Hemitelia* sp., *Balmeisporites* sp., *Vacuopollis* spp., *Nudopollis* Pf., *Extratriporopollenites* Pf., *Postnormapolles* Pf., *Manci-*

*corpus* N. Mtch., *Aquilapollenites* Rouse *et* N. Mtch.;
- rare: *Camarozonosporites* Kr., *Taurocusporites reduncus* (Bolch.) Stover, *Stenozonotriles radiatus* Chl., *Divisisporites eukirchenensis* Th., *Foraminisporis barangaensis* (Nagy) Pacl.;
- microphytoplankton abundant.

Santonian, SPA IV.4:
- dominants: *Gleicheniidites senonicus* Ross., *G. laetus* (Bolch.) Bolch., *Plicifera delicata* (Bolch.) Bolch., *Pinus* sp., *P. aralica* Bolch., *Cedrus parvisaccata* Sauer, *C. pisilla* Sauer;
- subdominants: *Concavisporites* spp., *Matonisporites* spp., *Polypodiisporites flexus* Chl., *Laevigatosporites ovatus* Wils. *et* Webst., *Cyathidites australis* Coup., *C. minor* Coup., *C. punctatus* Delc. *et* Sprum., *Cedrus pachiderma.* Sauer, *Taxodiaceae, Casuarinidites cainozoicus* Cook. *et* Rike, *Triorites harrisii* Coup., *Triporopollenites plicoides* Zakl., *Betulaepollenites microexelsus* P. Rot., *Scabratricolpites legibilis* Samoil., *Kuprianipollis santaloides* (Stelm.) Kom., *K. elegans* (Zakl.) Kom., *Complexiopollis* spp., *Vacuopollis* spp., *V. pyramis* Pf.;
- attendants: *Appendicisporites* sp., *Cicatricosisporites* sp., *Hemitelia mirabilis* Bolch., *H. separata* Chl., *H.* sp., *Balmeisporites ratus* Kond., *B. striatus* Kond., *B.* sp., *Thomsonipollis magnificus* (Th. *et* Pf.) Kr., *Concavipollis* Pf., *Multiporopollenites* sp., *Bombacacidites* sp., *Liliacidites* sp., *Monocolpites* sp., *Symplocacites* sp., *Proteacidites* sp., *Triporopollenites* sp., *Trudopollis* sp.;
- rare: *Camarozonosporites* Kr., *Taurocusporites reduncus* (Bolch.) Stover, *Stenozonotriletes radiatus* Chl., *Divisisporites eukirchenensis* Th., *Foraminisporis batangaensis* (Nagy) Pacl.;
- microphytoplankton abundant.

Turonian, SPA IV.3:
- dominants: *Gleicheniidites* spp., *Selaginella* spp., *Plicifera delicata* (Bolch.) Bolch., *Pinaceae*;
- subdominants: *Taurocusporites reduncus* (Bolch.) Stover, *Cyathidites australis* Coup., *C.* spp., *Hemitelia maxonii* Ros., *Matoniasporites* spp., *Lygodium* spp., *Contignisporites perplexus* Sind., *Laevigatosporites ovatus* Wils. *et* Webst., *Polypodiisporites flexus* Chl., *Retitricolpites* spp., *Tricolpites* cf. *reticulatus* Cook., *T. erugatus* Hedl. *et* Norris, *Quercites sparsus* (Mart.) Samoil., *Araliaceae, Rutaceae, Nyssapollenites* sp., *Polyporites clarus* N. Mtch., *Monocolpites bisulcus* Mart., *Liliacidites* sp., *Disulcites reticulatus* Pot., *Ericipites* sp.;
- attendants: *Camarozonosporites ratus* Kr., *C.* spp., *Concavisporites kainophyticus* Voron., *C. junctum* (K.-M.) Semenova, *Kornilovites crispus* Kalm., *K. trisegmentatus* Kalm., *Cicatricosisporites perforatus* (Mart.) Voror., *C. exilioides* (Mal.) Voron., *C. dorogensis* Pot. *et* Cell., *Appendicisporites* sp., *Anemia* sp., *Complexiopollis* Pf., *Kuprianipollis* Kom., *Turonipollis* Ameron, *Tricolporopollenites* Pf., *Triarites*;
- microphytoplankton rare.

Late Cenomanian-early Turonian, SPA IV.2:
- dominants: *Gleicheniidites* sp., *G. senonicus* Ross., *G. laetus* (Bolch.) Bolch., *G. stellatus* (Bolch.), *Plicifera delicata* (Bolch.) Bolch., *Pinaceae*;
- subdominants: *Cyathidites australis* Coup., *C.* spp., *Hemitelia maxonii* Ros., *Matoniaspornes* spp., *Lygodium* sp., *L. japoniciforme* E. Iv., *L. granulatum* E. Iv., *Contignisporites perplexus* Sing., *Laevigatosporites ovatus* Wils. *et* Webst., *Polypodiisporites flexus* Chl., *Retitricolpites vermimurus* Brenn., *R. granosus* Hedl. *et* Norris, *R. vulgaris* Pierce, *Tricolpites* cf. *reticulatus* Cook., *T. erugatus* Hedl. *et* Norris, *Rousea micilipollis* Srivast., *Viburnum* sp., *Quercites sparsus* (Mart.) Samoil., *Araliaceae, Rutaceae, Nyssapollenites* sp., *Polyporites clarus* N. Mtch., *Monocolpites bisulcus* Mart., *Liliacidites* sp., *Disulcites reticulatus* Pot., *Ericipites* sp.;
- attendants: *Camarozonosporites ratus* Kr., *C.* spp., *Concavisporites kainophyticus* Voron., *C. junctum* (K.-M.) Semenova, *Kornilovites crispus* Kalm., *K. trisegmentatus* Kalrm., *Cicatricosisporites perforatus* (Mart.) Voron., *C. exilioides* (Mal.) Voron., *C. dorogensis* Pot. *et* Cell., *Appendicisporites* sp., *Anemia* sp., *Complexiopollis* Pf., *Kuprianipollis* Kom., *Turonipollis* Ameron, *Tricolporopollenites* Pf., *Triarites* sp.;

- rare: *Taurocusporites reduncus* (Bolch.) Stover, *T. segmentatus* Stover, *Foraminisporis wonthagiensis* (Cook. *et* Dettm.) Dettm.;
- microphytoplankton rare.

Early-middle Cenomanian, SPA IV. 1:
- dominants: *Gleiheniidites* sp., *G. senonicus* Ross., *G. laetus* (Bolch.) Bolch., *Pinus, Cedrus, Podocarpus, Dacridium., Phyllocladites;*
- subdominants: *Dicksoniaceae, Cyatheaceae, Matoniaceae, Polypodiaceae, Lygodium* sp., *L. japoniciforme* E. Iv.;
- attendants: *Lophotriletes, Hymenozonotriletes, Camarozonosporites, Concavisporites, Cicatricosisporites* sp., *Appendicisporites* sp., *Anemia* sp., *Castanea vakhraneevi* Bolch., *Tricolpites sagax* Norris, *T. albiensis* Kemp., *Cipuliferoidaepollenites minutus* (Brenner) Sing., *Platanus orientaliformis* Samoil., *Menispermum turonicum* N. Mtch., *Quercites sparsus* (Mart.) f. *vescus* Samoil., *Rhamnaceae* ;
- rare: *Cinguulatisporites eukirchensoides* Delc. *et* Sprum., *Taurocusporites reduncus* (Bolch.) Stover, *Peromonolites reticulatus* Brenner, *Typha* sp.

FLORA

Leafy flora assemblage LFA I:
- *Asplenium dicksonianum* Heer, *Onychiopsis psilotoides* (St. *et* Webb) Ward, *Gleichenia* sp., *Cladophlebis foergeissenii* (Heer) Vachr., *C. kuldensis* Vachr., *Sphenopteris* sp., *Nissonia kazachstanica* Vachr., *Otozamites jarmolenkoi* Vachr., *Zamites* ? sp., *Podosamites ellipsoides* Sap., *Sequoia heterophylla* Velen., *S. fastigata* Heer, *Magnolia* sp., *Menispermites kryschtofovichii* Vachr., *Myrica* ? *kuldensis* Vachr., *M. zenkeri* (Ett.) Heer., *Platanus pseudoguillelmae* Krass., *P. cuneiformis* Krass, *P. golenkinii*, Vachr., *P. primaeva* Lesq., *P. newberryana* Heer., *Dalbergites sewardiana* (Shap.) Vachr., *D. simplex* (Newb.) Sew., *Leguminosites ovalifolius* Heer, *Acer janschinii* (Vachr.) Vachr., *Ziziphus menneri* Vachr., *Vitis cretacea* Vachr., *Cissites uralensis* Krysht., *Aralia formosa* Heer, *Diospyros primaeva* Heer, *Dicotylophyllum rhomboidale* Vachr.

Aktyubinskian Priuralie, Western Primugodzharie, Upper Albian-Cenomanian.

So called Koldenen-Temirskian flora (according to Shilin, 1986).

Leafy flora assemblage LFA II:
- *Regnellidium* sp., *Taxites kasachstanica* Shilin, *Magnollia alternans* Heer, *M. amplifolia* Heer, *Laurophyllum* sp., *Platanus* sp., *P. pseudoguillelmae* Krass., *P. cuneiformis* Krass., *Celtidophyllum praeustrale* Krass., *Dalbergites simplex* (Newb.) Sew., *Ilex* sp., *Ziziphus ajatensis* Vachr., *Diospyros primaeva* Heer, *Eucalyptus uralensis* Vachr.

Turgay trough, Cenomanian-Turonian.